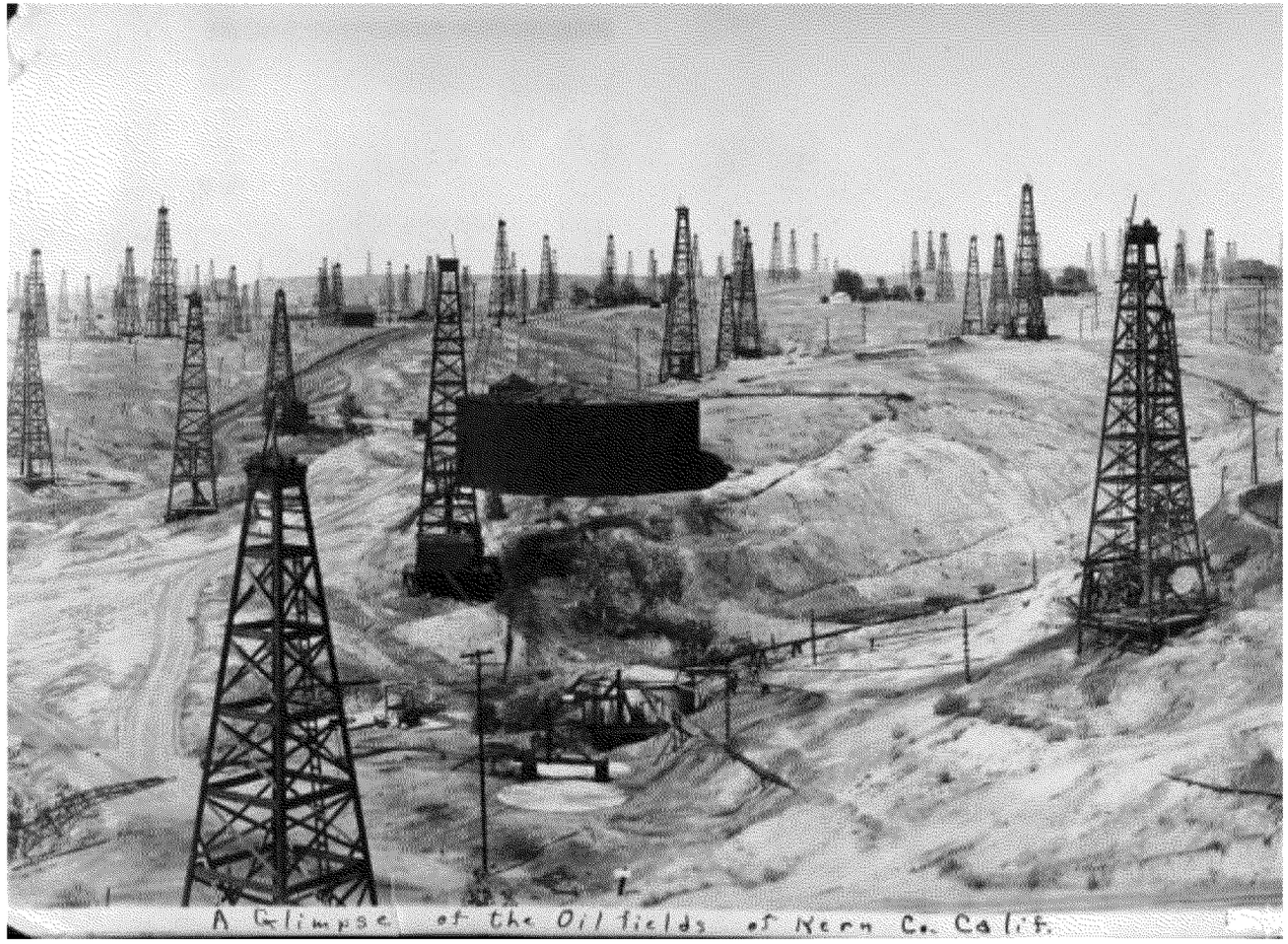
Overview of Produced Water Management in California

Irrigation and Groundwater Banking Project, Infiltration/Percolation Pits, and UIC



Irrigation in the media

grapes, citrus, melons, peaches, root vegetables, nuts

These Popular Fruit and Veggie Brands May be Grown With Oil Wastewater

The practice is gaining popularity in drought-plagued California, but is it safe?

—*By* ***Josh Harkinson*** | Fri Jul. 24, 2015 6:00 AM EDT

AP Images

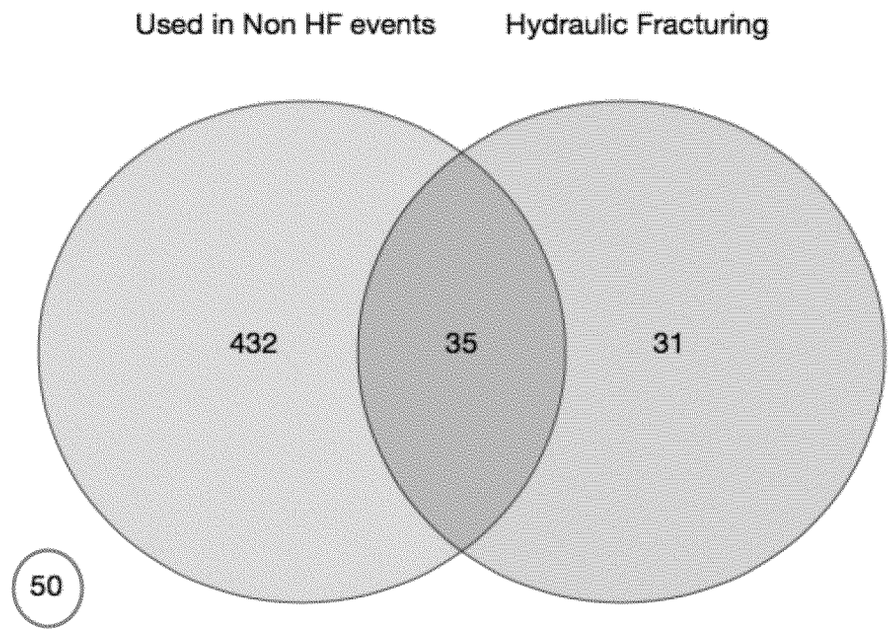
California: Central Valley—Kern County

76,000 active O&G wells with >50% in Kern County

PSE Healthy Energy Study

South Coast Air Quality Management District Database

Significant overlap in Chemicals used in hydraulic fracturing events and in non-hydraulic fracturing events



PSE Healthy Energy Study

South Coast Air Quality Management District Database

Summary of available Chemical data for Non-Hydraulic Fracturing Events

Number of chemicals	Proportion of all Chemicals	Identified by unique CASRN	Toxicity	Quantity of use
151	30%	Available	Available	Available
1	0%	Available	Available	Unavailable
97	18%	Available	Unavailable	Available
43	8%	Unavailable	Unavailable	Available
233	44%	Unavailable	Unavailable	Unavailable

Note: These data do **NOT** include chemicals from hydraulic fracturing or matrix acidizing events

Currently, 5 oil fields providing produced water for irrigation

Table 3.

Projects where oil-field wastewater is permitted for reuse for crop irrigation in California.

Date permitted	County	Oil field	Operator	Permitted Volume (acre-feet per year)	Water treatment	Blending	Application	Crops irrigated	User	Data source
	Tulare	Deer Creek			Mechanical separation with addition of coagulants	No	Irrigation	Alfalfa	Private land	1
	Tulare	Deer Creek			Mechanical separation with addition of coagulants	No	Irrigation	Alfalfa	Private land	1
	Kern	Jasmin			Mechanical separation with addition of coagulants	Blended with canal water some of the time	Irrigation	Citrus	Jasmin Ranchos Mutual Water Company	1
	Kern	Mount Poso					Irrigation		Cawelo Water District	1
2012	Kern	Kern River	Chevron	37,500	Mechanical separation, sedimentation, air flotation, and filtration (walnut hull filters)	Treated wastewater, imported surface water, groundwater	Irrigation, groundwater recharge	99% permanent crops (citrus, almonds, pistachios, apples, peaches, plums, and vineyards); 1% (alfalfa, potatoes, corn, grains, vegetables, melons)	Cawelo Water District	1, 2
2012	Kern	Kern Front	California Resources Corporation	16,600		Treated wastewater, imported surface water, groundwater	Irrigation, groundwater recharge	Same as above	Cawelo Water District	1, 4
2011	Kern	Kern Front	Hathaway LLC	70	No treatment requirements	7% wastewater; 93% groundwater	Irrigation; during non-irrigation season, disposed of via underground injection	Citrus	Concordia Ranch	3, 7

Pacific Institute report continued

Table 3. (continued)

Date permitted	County	Oil field	Operator	Permitted Volume (acre-feet per year)	Water treatment	Blending	Application	Crops irrigated	User	Data source
2015	Kern	Kern Front	California Resources Corporation	21,200	Gas separation, free-water knock-out tanks, air flotation, and skimming	Produced water, surface water, and groundwater blended in the Lerdo Canal	Irrigation, groundwater recharge in the Rosedale Basin	80% permanent crops of nuts, vineyards, and fruit	North Kern Water Storage District	5
2014	San Luis Obispo	Arroyo Grande	Freeport-McMoran Price Canyon	940	Mechanical, chemical, reverse osmosis	Yes (indirect reuse)	Discharged to Pismo Cree to improve habitat and water quality in the creek. Water in the creek is recharging groundwater and reused indirectly by downstream irrigators with wells.	Vineyards, row crops	Private land	6

Notes: Blanks indicate unknown or missing data.

Sources:

(1) Email to the authors from Dane Johnson, Senior Engineering Geologist, Central Valley Regional Water Quality Control Board, 2014.
(2) Central Valley Regional Water Quality Control Board (CVRWQCB). (2012). Waste Discharge Requirements for Chevron USA, Inc., and Cawelo Water District, Produced Water Reclamation Project, Kern River Area Station 36, Kern River Oil Field, Kern County. http://www.waterboards.ca.gov/centralvalley/board_decisions/adopted_orders/kern/r5-2012-0058.pdf
(3) CVRWQCB. (2011). Conditional Waiver of Waste Discharge Requirements and Monitoring and Reporting Program for Hathaway, LLC Reuse of Oil Field Production Wastewater for Irrigation. http://www.waterboards.ca.gov/centralvalley/board_decisions/tentative_orders/1110/hathaway/3_hathaway_waiver_res.pdf
(4) CVRWQCB. (2012). Order No. R5-2012-0059 Waste Discharge Requirements for Valley Water Management Company and Cawelo Water District, Produced Water Reclamation Project, Kern Front No. 2 Treatment Field, Kern Front Oil Field, Kern County. http://www.waterboards.ca.gov/centralcoast/board_decisions/adopted_orders/2013/2013_0029_freeport_npdes_permit.pdf
(5) California Regional Water Quality Control Board, Central Valley Region Monitoring And Reporting Program, No. R5-2015-XXXX for California Resources Corporation, LLC And North Kern Water Storage District, Oil Field Produced Water Reclamation Project, Kern County. http://www.waterboards.ca.gov/centralvalley/board_decisions/tentative_orders/calrescorp/crcnkwsd_mrp.pdf
(6) CVRWQCB. "Notice Tentative Waste Discharge Requirements for California Resources Corporation, LLC and North Kern Water Storage District Oil Field Produced Water Reclamation Project Kern County," September 18, 2015. http://www.waterboards.ca.gov/centralvalley/board_decisions/tentative_orders/calrescorp/crcnkwsd_cov.pdf
(7) California Regional Water Quality Control Board, Central Valley Region Monitoring and Reporting Program, R5-2011-XXXX for Hathaway, LLC, Reuse Of Oil Field Production Wastewater for Irrigation, Kern Front Oil Field, Kern County. http://www.waterboards.ca.gov/rwqcb5/board_decisions/tentative_orders/1110/hathaway/4_hathaway_mrp.pdf

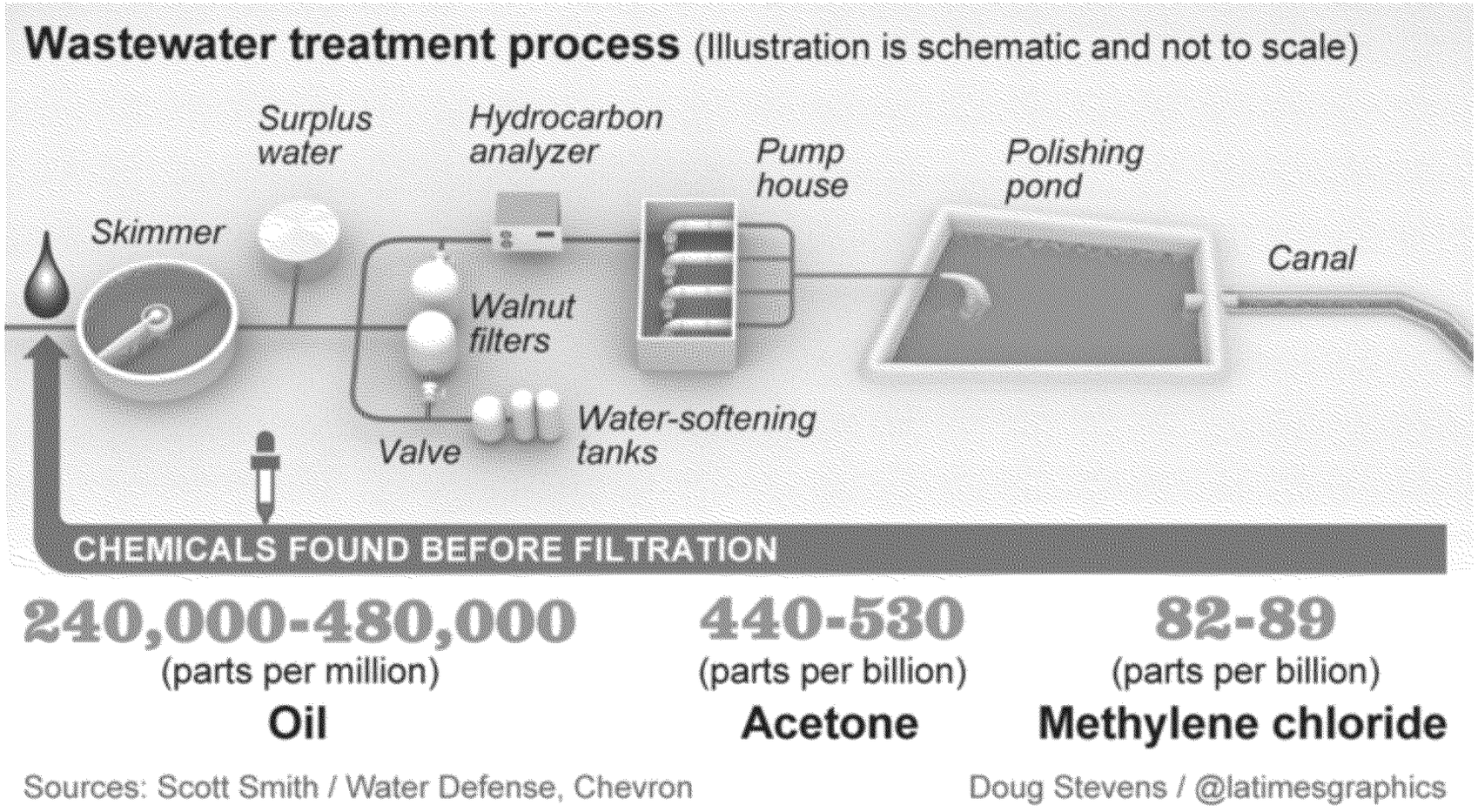
Irrigation and Groundwater Banking

(Chevron)

- NPDES permit revoked for Paso Creek discharge
- California Regional Water Quality Control Board
  - Waste Discharge Permit issued for “blended oilfield produced water” to irrigation and/or Famoso Groundwater Banking Project
  - Low level of salts—high naturally occurring arsenic
  - Walnut shell filtration
  - Continuous monitoring: Flow, EC
  - Monthly monitoring: arsenic, boron, chloride, oil & grease, TSS, pH and general minerals
  - Every 5 years: Priority Pollutants (see list)
    - Doesn’t look for O&G specific constituents
    - Disclosure not required
    - ~WET not required

Produced Water Treatment

(Chevron)



Irrigation and Groundwater Banking

(Chevron)

Irrigation

- Reports claim Chevron supplying produced water >20 years for irrigation to
- 80% produced water to 20% fresh water

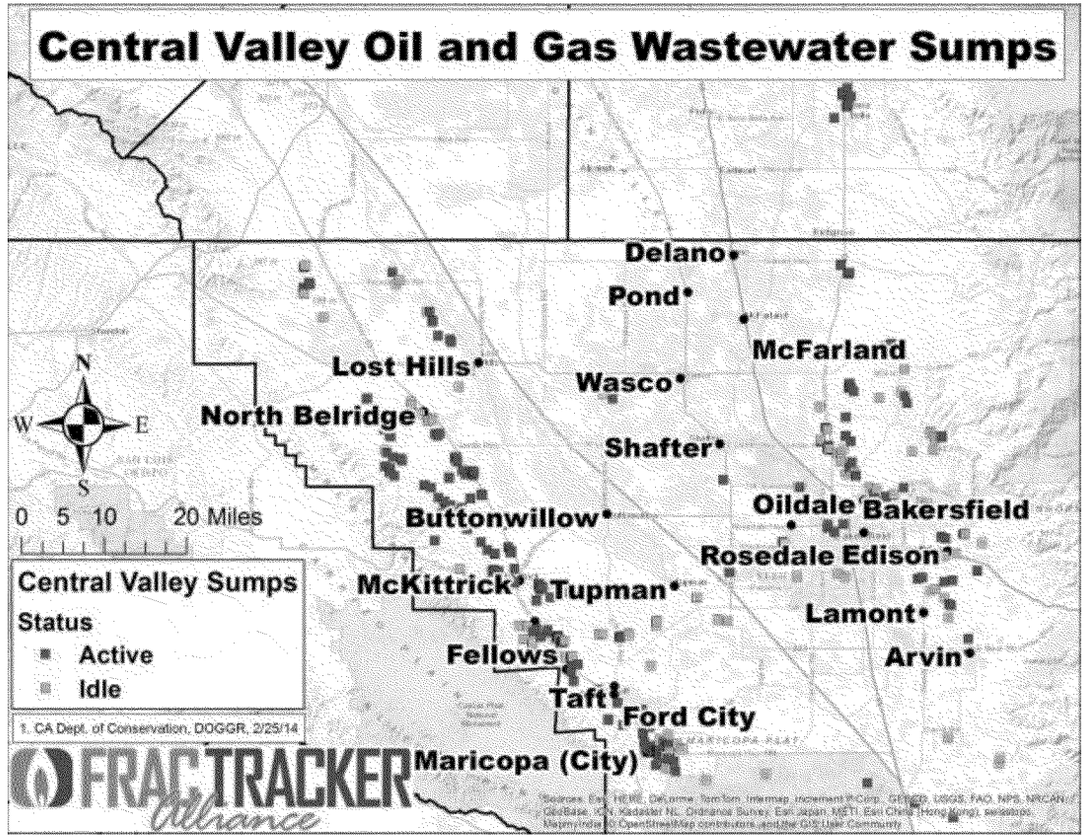
Famoso Groundwater Banking Project

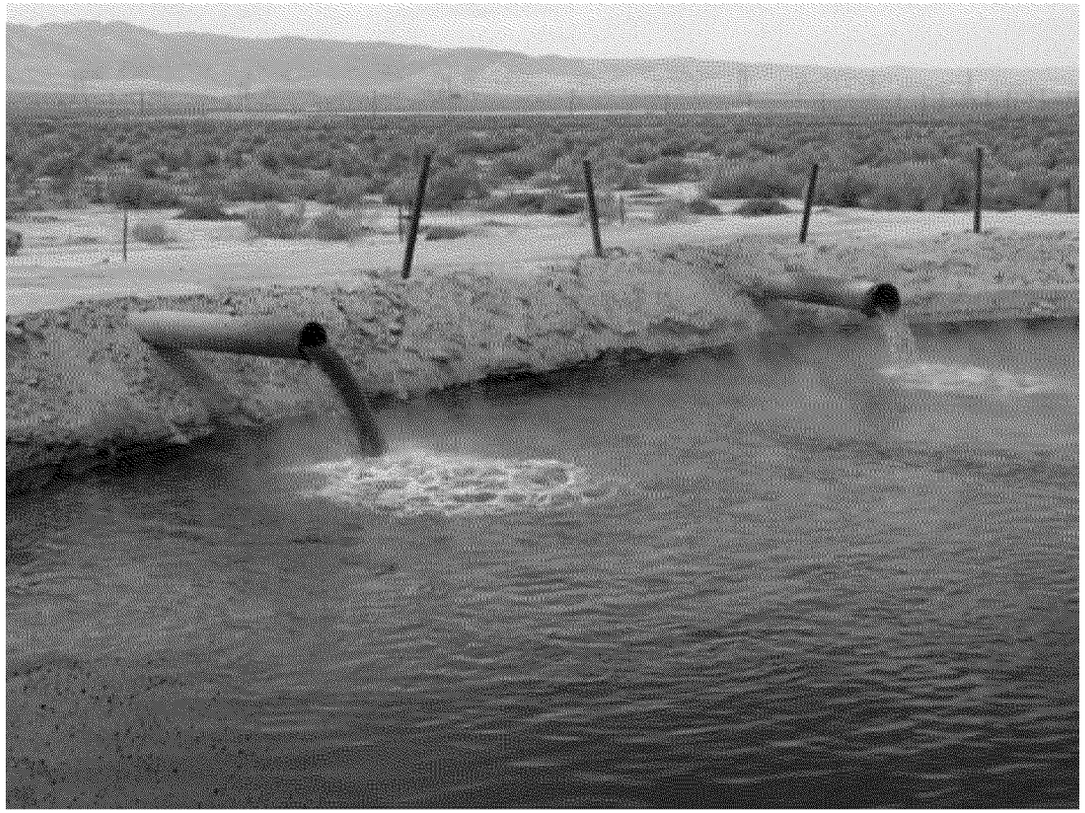
- Blended with surface water supplies “to the extent they are available”

Groundwater Banking outside Kern County (PI Report)

- Recharging groundwater that is being used for irrigation—mostly vineyards but some row crops
- RO treated water discharged to post-treatment constructed wetlands and aquifer recharge basins—goes downslope to Salinas River and Salinas Valley Aquifer—used for municipal and industrial supply and irrigation—not sure about testing requirements

Percolation/Infiltration Pits





Percolation/Irrigation Pits

(Clean Water Action video)

Temporary Storage Pits

- Used to store drilling fluid, cuttings, naturally occurring chemicals, and chemicals and materials used in drilling process
- CA law doesn't require pits to be lined; though prohibits permanent disposal in open pits
- 1995 data (most recent):
  - Majority of solid waste buried onsite
  - Liquid Waste: 56% spread on land, 24% evaporation, 18% onsite remediation

UIC

- EOR: reuse of produced water and fresh water
  - Fresh: 72% domestic, 25% groundwater, 1.6% wastewater from industry
- Steam Injection
- Aquifer Exemptions Issues—media and recent NRDC Petition
  - Injection into USDWs without AEs

Expert Panel: White Paper-boundaries not identified but focus is on agriculture; to date-crops and soil have not been tested

April 14th call with discuss Region 8:

1. Monitoring Programs
2. Produced Water Management Profile and Issues
3. Examples of State and EPA/Federal collaborations on management strategies
4. State examples that can be shared

Future could see more recycling of produced water in chronically water-short regions. Operators looking for additionally management strategies as produced water volumes increase.